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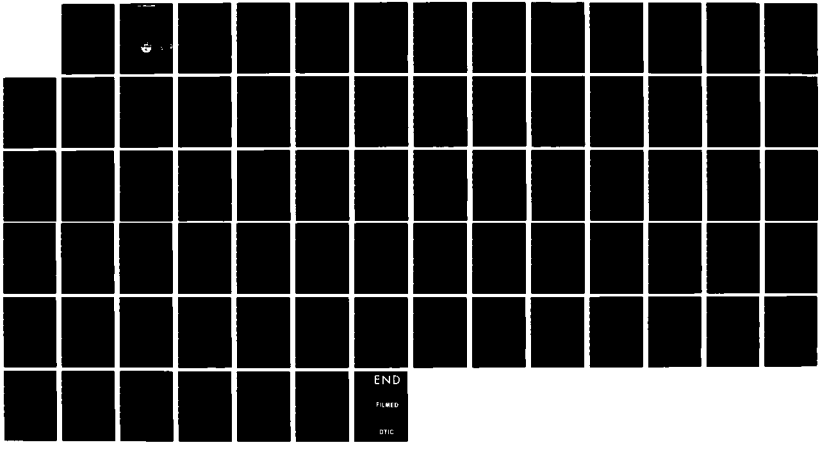

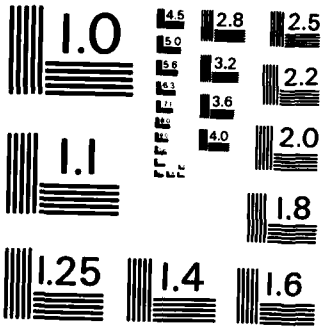

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LIFE CYCLE TRAINING COST MODEL

NAVY PERSONNEL RESEARCH
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LIFE CYCLE TRAINING COST MODEL

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FOREWORD

The initial training life cycle model described herein was developed in support of Navy Decision Coordinating Paper, Manpower Requirements Development System (NDCP-Z0109-PN) subproject Z0109-PN.03, Manpower Cost in Systems Design. It was sponsored by the Deputy Chief of Naval Operations (OP-01). The objective of the subproject is to reduce manpower requirements and the associated life cycle costs of new hardware systems. Information and techniques are being developed to assist hardware developers in assessing the people-related implications of their designs and for conducting manpower cost-effectiveness analyses during the design process.

This report, the second in a series concerning training system costing, describes an initial life cycle training cost model. The first report, NPRDC Technical Note 81-10, examined the state of the art in training costs and life cycle costing techniques.

The purpose of the cost model is to identify those training elements having significant cost implications for initial and follow-on hardware system training. Through the use of such a model, training costs can be predicted and used in early-effectiveness assessment studies to assess more accurately the cost implications of alternative hardware systems.

This cost model was developed in 1978 and subsequently utilized in improving the Navy Enlisted Billet Cost Model. The effort is documented at this time to make it available to the research community.

The contracting officer's technical representative was Mr. John F. Brock.

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SUMMARY

Problem

Training costs have been an increasing contributor to the life cycle costs of military weapon systems. As the concept of training has broadened and alternative approaches to training have become available through the development of new technologies, the difficulties of determining and projecting training costs have increased.

Objective

The objective of this effort was to develop a model for determining the cost of all training activities required to support a Navy weapon system during its entire life cycle.

Approach

The weapon system life cycle phases and their associated training requirements were examined. To organize the many kinds of training involved and to simplify the process of determining training costs, a unit of training was chosen for a model. The unit was the single iteration of a course defined as a three-dimensional matrix whose axes are course (development) phases, training activities, and cost elements. This course was then expanded across iterations and modifications in its evolution through the life cycle of the weapon system.

Results and Conclusions

1. Using the course as a training unit, an initial model was developed to determine the cost of training required for the life cycle of a weapon system.

2. At this level of development, the model provides a structure for relating the training required during weapon system development and test with the subsequent initial crew and ongoing replacement training. It provides a single coherent point of reference for system training managers, instructional technologists, and training cost accountants alike.

3. The life cycle training cost model is descriptive rather than directive. The finest level of detailing of the model was chosen to exploit the finest level of costing

information likely to be available, while still leaving the model general enough to be applicable to the widest number of alternative forms of training and training development.

Recommendations

1. The model should be applied to an actual weapon system for both fine tuning and validation.

2. Future work should build upon the structure of this model to create the cost base necessary for developing a life cycle training cost model and supporting data base including specific cost figures and formulas needed to establish costs for individual training systems.

CONTENTS

LIST OF FIGURES

INTRODUCTION

Problem

As weapon systems become more complex and military budgets become tighter, all aspects of system acquisition and ownership must become even more cost effective. Personnel costs have become the major percentage of weapon system life cycle costs and training costs represent an increasing percentage of personnel cost that cannot be determined confidently, because life cycle system-oriented training is not well enough defined. The managers responsible for planning and coordinating training during the life cycle of a weapon system need a life cycle training model that will bring all of the system required training into a single coherent structure, detail all the activities and materials needed to develop and carry out this training, and provide overall guidance for the costing--historical or projected--of the training required by a specific weapon system.

Objective

The objective of this effort was to develop a model for determining the cost of all training activities required to support a Navy weapon system during its entire life cycle.

Background

Most of the literature in the area of training and training cost models (Skeen & Jackson, 1981) addresses ongoing career development training such as that involved in "A" schools. Very little has addressed the training required for specific systems. A large amount of the literature is directive--it gives systematic guidance for developing and conducting training. The diverse approaches of existing models make their use impractical to aid in costing training for all the ways it may be developed and carried out. In any large weapon system the diversity of kinds of courses and course development efforts must be accommodated rather than restricted to any one form of approach to training.

In addition to these problems, the scope of latest evolutions of existing models is insufficient for the life cycle training costing. Most concentrate on the process of systematic course development and operation--or conduct--rather than on the training

system as a whole (Schumacher, Pearlstein, & Martin, 1974), with training system management and support functions receiving scant attention. These models also assume the availability of relatively well established training requirements, as well as adequate system and maintenance engineering analysis documentation. In fact, for much of the early training for systems development and test personnel, these requirements and documentations are rarely available, making a complete development approach such as the Interservice Procedures for Instructional System development (IPISD) (Branson, Rayner, Cox, Furman, & King, 1975) impossible or impractical.

APPROACH

The conventional practice to develop the model in block diagram form was abandoned when it was discovered this format might interfere with attempts to cost efforts following divergent development paths. The block flow format was abandoned in order to keep the model descriptive.

The level of granularity or detail that the model should have to guide the process of costing training is a related consideration. Obviously, too little detail would give inadequate guidance. However, too much detail would make the model difficult to apply to the current diversity in training and training development approaches.

In attempting to find a reasonable approach to these problems, this model is presented in narrative form, rather than in a directive process flow chart. The level of detail for this initial model was chosen to give adequate guidance to cost identification while being general enough to accommodate most kinds of training and training development. The model describes all the categories of activities and materials that may be required to produce any training without specifying the nature of the activities nor the particular materials that may be used.

To make the presentation of the model clearer, the context in which system training takes place--the weapon system development cycle--was examined. The kinds and numbers of people requiring training for a system development are understood best in this

context, thereby giving an indication of the major categories of personnel who will require training in a complex weapon system development, as well as the timing of the various kinds of training during this cycle.

Next, the detailed nature of the training unit was examined by (1) selecting the course as the unit for the model unit and determining the overall nature and life cycle of a course, (2) analyzing a course into the activities necessary to develop and conduct it, and (3) adding a system for categorizing the costs associated with the activities. The course was represented in the form of a three-dimensional matrix.

An example of a model of the life cycle training for a given system was generated to illustrate how complex large system training can become. A single course might be repeated unchanged many times, or it might be modified successively as purposes and conditions change. Depending on the size and complexity of the system, the model expands to accommodate the numbers of different courses required. The model is only illustrative since each system's requirements will determine its model's form.

Finally, some of the complications of using the model as a costing guide were addressed briefly.

MODEL DEVELOPMENT

Weapon System Development Cycle

Training and training related activities occur throughout the 30 or so years in the life cycle of a modern weapon system (e.g., DD 963 or LHA). Figure 1 illustrates the events of a typical weapon system development cycle and the approximate level of training activity associated with each phase:

1. The life cycle of a weapon system consists of three major phases. (a) In the planning and technology evolution phase, enemy threat analysis and technology studies are combined to produce the concept for a weapon system capable of neutralizing the threat. (b) In the weapon system acquisition phase, systems are evaluated on a performance/cost basis. After a weapon system has been selected, the rest of this phase consists of

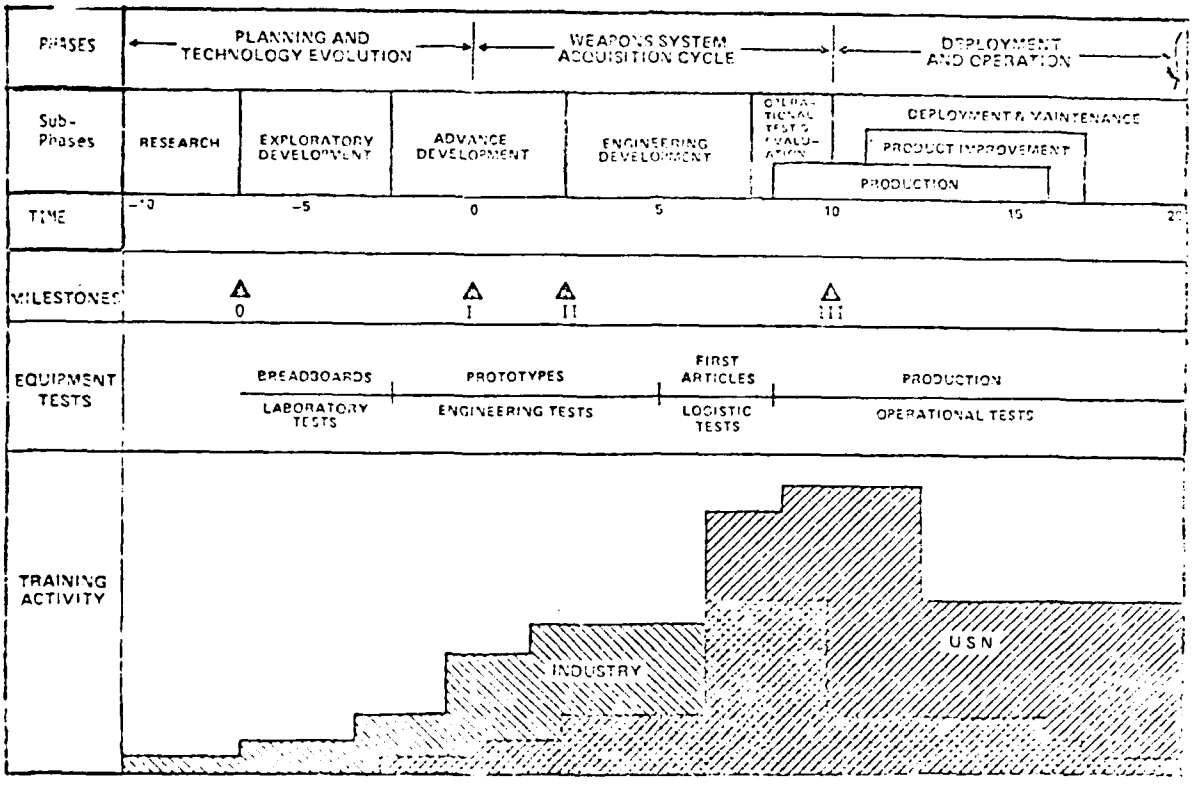


Figure 1. Weapon system development cycle.

developing the full capability and transitioning the system to the operating service. (c) In the deployment and operation phase, the system is used in mission accomplishment, and is operated and maintained by the military service.

2. The typical system subphases, shown in Figure 1, are representative only. When they start and stop, would vary from one system to another.

3. A 30-year time span is illustrated with year zero at the start of the acquisition phase.

4. The acquisition of a weapon system is an extremely expensive undertaking in terms of both dollars and personnel. Approval milestones divide the acquisition phase into program initiation, demonstration and validation, full-scale development, and production. Authority and funding to continue major weapon system development beyond each milestone must come from the Defense System Acquisition Review Council (DSARC) and the Secretary of Defense.

5. The weapon system equipment evolution and its related tests are also shown in Figure 1. Trained personnel must be available throughout the life cycle to perform the required equipment tests.

6. The lower portion of Figure 1 is a representation of the level of training activity by industry and the Navy. Typical training tasks are requirements establishment, planning and design, development, and operation and control of training programs.

The life cycle phases for ships and related equipment shown in Figure 2 (from NAVSEAINST 4105.1), are used as the framework for identifying training requirements. While the phase titles of Figure 2 differ somewhat from the subphases in Figure 1, the ships activities correspond to other DoD acquisition processes and a comparison can be made by aligning the DSARC milestones of the acquisition phase.

The systems/equipment section of Figure 2 is labeled similarly to other DoD acquisition processes, but lacks the comprehensiveness and terminology associated with the ship acquisition phases.

	DSARC I		DSARC II	DSARC III	
SHIPS	FEASIBILITY DESIGN	PRELIMINARY DESIGN	CONTRACT DESIGN	DETAIL DESIGN AND LEAD SHIP CONSTRUCTION/PRODUCTION	DEPLOYMENT/ OPERATION
SYSTEMS/ EQUIPMENT	CONCEPTUAL PHASE		ADVANCED DEVELOP-MENT	FULL SCALE DEVELOPMENT / PRODUCTION	DEPLOYMENT/ OPERATION

Figure 2. Ship/system equipment life cycle phases (from NAVSEAINST 4105.1).

listed as a cost element for both prime and training equipment, refers to such things as punched or magnetic tapes, card decks, and floppy disks. The development costs of these software items are part of their equipment budgets and are subject to the same controls.

4. Material and supplies are the consumable items (normally low cost, high usage, and nonrepairable items) that are a part of a training activity. Technical and training manuals are considered consumables, because of the quantities used in a training environment.

5. Transportation includes travel and relocation costs of training personnel, as well as packing, handling, storage, and transportation (PHST) of equipment and data.

6. Miscellaneous contains elements that might be insignificant if considered separately. However, collectively their total dollar costs across the training life cycle might be large and should be budgeted.

Cost Partitioning

To facilitate a thorough analysis of training course costs, each of the course phases identified earlier is listed in a format in Figure 6 that also includes each of the applicable cost elements. This format is also useful for listing and summarizing the details of the element costs in each phase as follows:

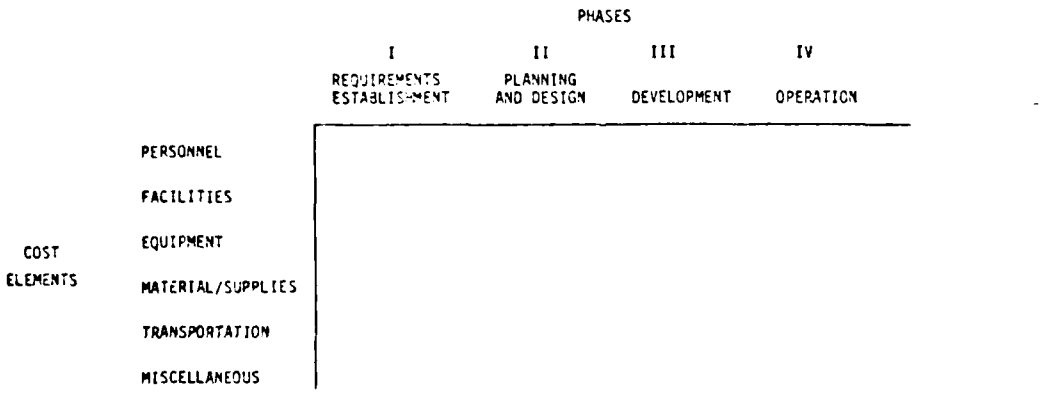


Figure 6. Cost elements per course phase.

1. Personnel costs typically account for the highest dollar costs during the training life cycle. They are certainly the most complex in composition. Figure 5 illustrates Navy officer and enlisted personnel support function cost factors. Other personnel training costs must be identified within contractor supported activities.

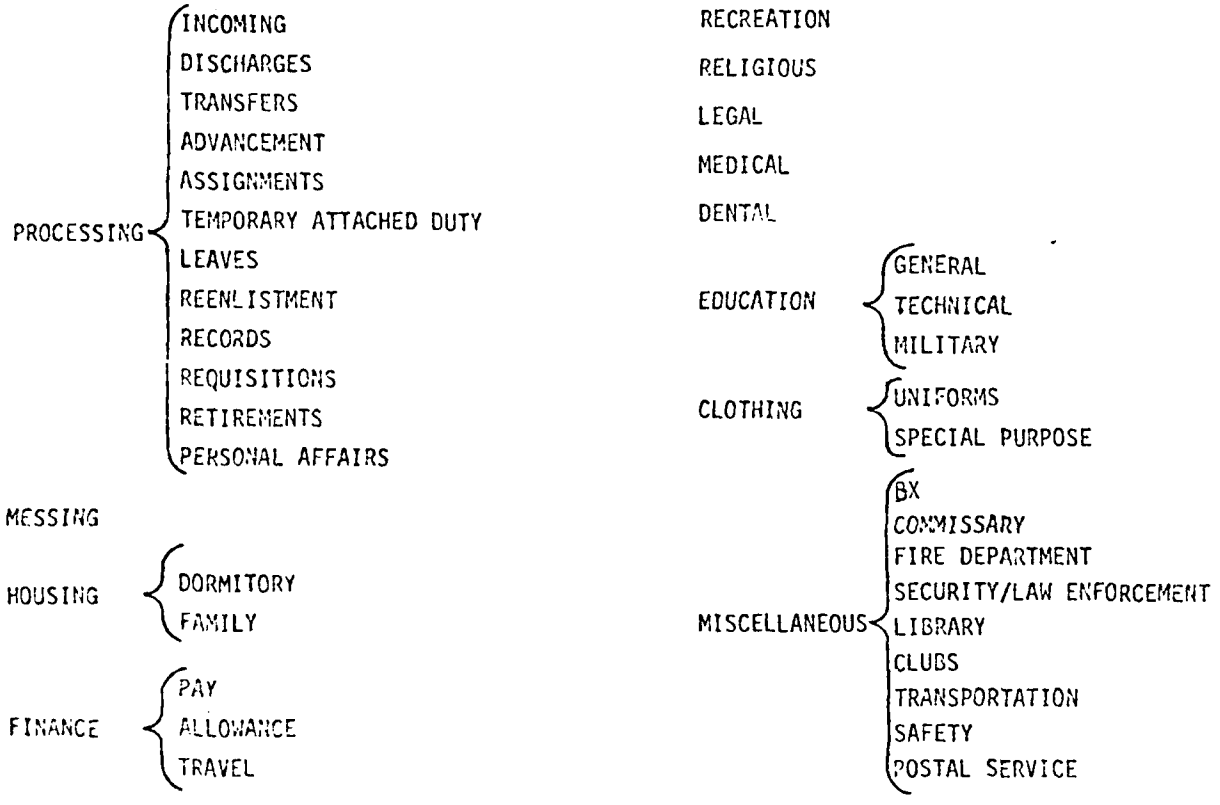
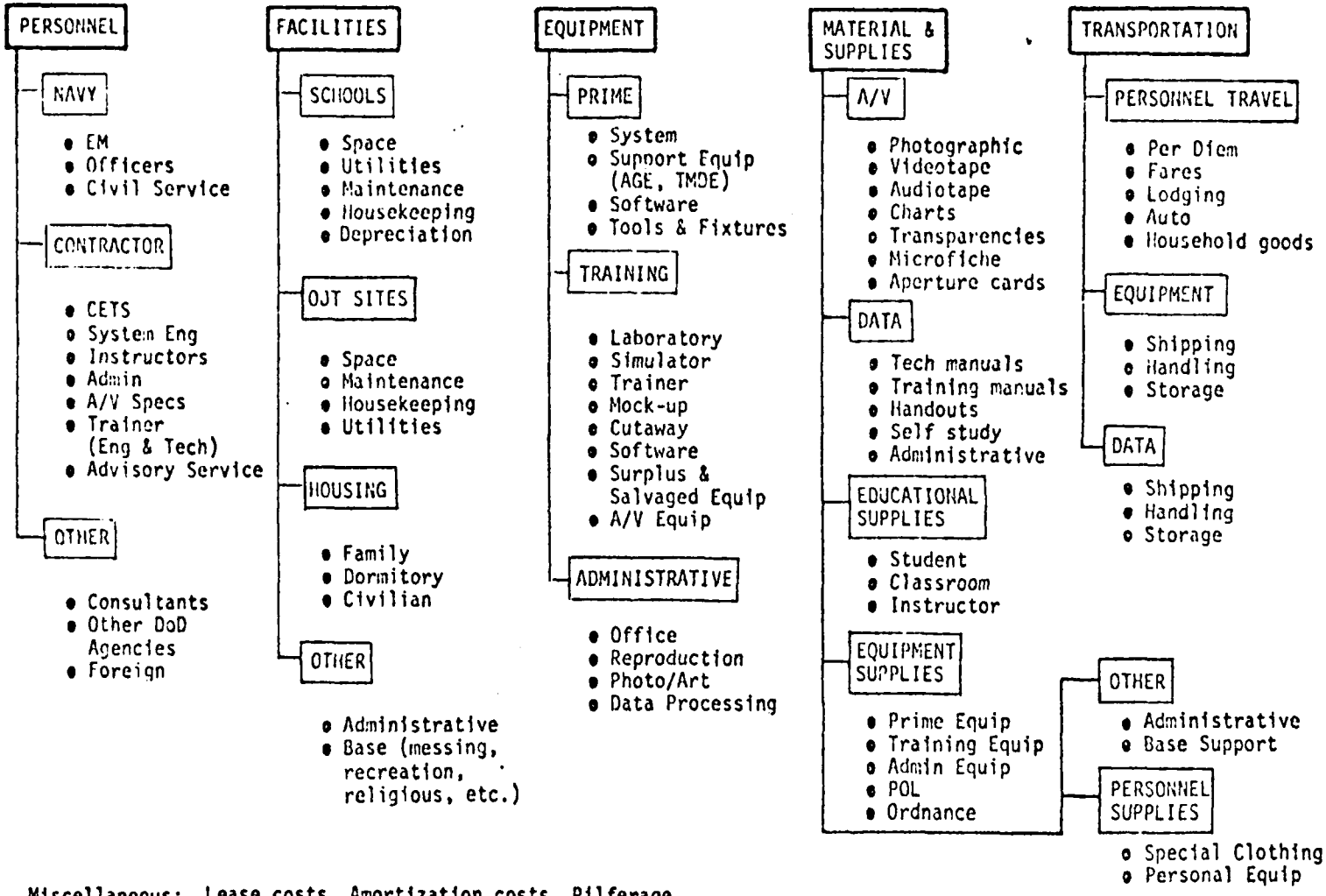


Figure 5. Navy personnel support function cost factors.

2. The facilities category is intended to represent all training related facilities from the size of a Navy base established for weapon system training down to the single classroom and office facility used for the smallest course. OJT sites are a consideration if the formal OJT requires classroom training aids or laboratory facilities.

3. Equipment is listed as prime equipment, training equipment, and administrative equipment, because they are budgeted and controlled separately. Software, which is



Miscellaneous: Lease costs, Amortization costs, Pilferage, Breakage, Obsolescence, Communications, Copyright costs.

Figure 4. Training Cost Elements

Course development may be viewed as a two-dimensional matrix of development phases and activities within each phase. The level of detail of the matrix is specific enough to identify all significant cost areas, but general enough to cover the variety of courses that a weapon system may require.

Training Course Costs

Cost Elements

This training cost model is intended to identify dollar costs for budget planning and evaluation of alternatives. Other cost measurements such as training days, student load, and space requirements should be considered in the final selection. However, identifying cost elements in terms of dollar has two advantages: (1) they are less subject to misinterpretation when evaluated by personnel from different disciplines (e.g., training, engineering, or finance). (2) The concept of discounting, where future costs may be measured against present costs, is easier to apply.

In some cases, however, dollar costs are simply not available or, even when they are, their validity is not always beyond reasonable doubt. References to costs herein refer to dollar costs.

The typical training course cost elements presented in Figure 4 are divided into these six categories that closely align with DoD cost accounts:

For any given course there will be various activities in the different phases unique to the course. All the activities (listed in Table 2) to require some level of effort, however minimal, in any course. To keep the model descriptive, no attempt has been made to specify the ways in which these activities should be carried out. With respect to costing, however, any of these activities might be conducted inhouse by the Navy or under contract. The kinds of patterns of costs will vary accordingly. For example, costing for inhouse work must include costs for overhead and any required interagency liaisons, while costing for contract work must include costs of procurement, contract monitoring, and perhaps different patterns of liaison.

The degrees of formality in the approach to these activities is quite different for the development of an initial one-time factory training course for RDT&E personnel than for the development of the same subject matter into ongoing crew training for the life cycle of a system. Also, with the continued improvement in instructional technology, different approaches to carrying out many of the activities will continue to be developed. It was not considered practical or desirable however, to develop the model to the level of detail required to specify all of the possible alternatives that the activities might take. For costing purposes, it was decided that these variations must be developed appropriately with respect to a specific system and the purposes of the costing exercise.

An attempt to detail the phase activities further without becoming directive or arbitrarily choosing between alternative approaches added some items to the initial lists (Appendix A). However, this effort was finally considered too detailed for practical guidance for costing. Perhaps the major item added was liaison with other agencies, which may be a significant cost factor in major course developments.

An efficient systematic approach to course development requires continual communication and interaction between all the individuals developing the various elements, since they all impact each other as the size and complexity of courses increase, these required interactions and their management add considerably to the costs.

Table 2

Activities During Course Phases

Element	Activity
Requirements Establishment Phase	
Course content/media	Establish requirements for course content and student evaluation: Task and skills analysis, qualitative and quantitative personnel requirements information, job qualification standards, probable mediaton.
Student	Establish student requirements: Numbers, kinds, timelines, logistic support.
Instructor	Establish instructor requirements: Numbers, qualifications, timelines, logistic support.
Hardware	Establish hardware equipment requirements: Numbers, kinds, timelines, logistic support.
Facilities	Establish facilities requirements for entire training system: Numbers, kinds, timelines, logistic support.
Evaluation	Establish training system evaluation requirements: Amounts, kinds (measures), timelines.
Management	Establish requirements for training system management: Amount, kinds, sharing with other activities, use of other (e.g., base).
Support	Establish requirements for support of the training system elements: Amount, kinds, schedules.
Plan and Design Phase	
Course content/media	Plan and design instructional strategy, course outline, behavioral objectives, mediation, lessons, lessonware development.
Student	Plan and design course entry requirements, pipeline, pretraining, remediation.
Instructor	Plan and design acquisition, development, training program.
Hardware	Plan and design acquisition/development, check out of all instructional, support, and administrative equipment.
Facilities	Plan and design assignment/construction, outfitting.
Evaluation	Plan and design training system evaluation materials and procedures.
Management	Plan and design management development and operation procedures.
Support	Plan and design support system development and operation.
Development Phase	
Course content/media	Develop and produce instructional materials, establish lessonware library and distribution procedures, validate materials and strategies.
Student	Develop pipeline, pretraining, remedial training; produce instructional materials, input to library; develop student assessment; validate materials; develop student assignment procedures.
Instructor	Develop instructor training courses and software; validate, develop instructor assignment procedures.
Hardware	Develop/acquire, install, check out; develop inventory and distribution procedures.
Facilities	Develop/acquire, prepare, check out.
Evaluation	Develop evaluation instruments and procedures, data storage and distribution system.
Management	Develop and check out management procedures, initial cadre.
Support	Develop and check out support procedures; support personnel training, logistics pipelines, etc., initial support cadre.
Operation and Control	
Course content/media	Maintain lessonware library; update, revise, assess schedules; distribute materials.
Student	Assess and assign, counsel, maintain academic records.
Instructor	Assess and assign maintain academic records, train, manage training, etc.
Hardware	Maintain inventory, assess and assign, operate, update, revise, distribute, maintain records.
Facilities	Assess and assign, update, maintain records.
Evaluation	Carry out evaluation procedures, collect, assess, distribute data, maintain records.
Management	Schedule activities; plan, budget, maintain records, etc.; direct support; carry out external liaison as required.
Support	Provide logistic support of all system elements: personnel, hardware, software, consumables, etc.

Elements of a Course

The course also has elements, but in this model, the concept is expanded to include everything required to carry out the training involved. The elements of the course, viewed this way, are defined in Table 1. It is assumed that every modern training system contains all of these elements and that everything involved in a training system fits into one of them.

Table 1

Definitions of Training System Elements

Element	Definition
Course content/media	Knowledge and skills to be learned in the course and the instructional software used to produce the learning.
Student (oriented)	Acquisition, support, preparation, and processing of students in the training system.
Instructor (oriented)	Acquisition, support, preparation, processing and utilization of instructors in the training system.
Hardware (equipment)	All of the instructional and administrative equipment used in the training system.
Facilities	Structures necessary to create learning environments, including any systems required for environmental control.
Evaluation	Measurement of training system performance.
Management (administration)	Management and support of the training system.
Support	Backing for ongoing successful operation of the other elements.

Activities Related to Course Elements

The major activities must be carried out relative to each element in each of the four training development phases are listed in Table 2. Much of the information for this table came from available literature on training models and Navy directives. Information was added for those areas that were obviously required for the development and operation of a training course, but received little or no formal attention in the literature surveyed.

The original definition of a course referred to an integrated set of instructional events. To freeze the course for the application of the model, a single iteration of an integrated set of instructional events constitutes the basic unit of the model.

Analysis of the Course Development Cycle

Course Development Phases

For this analysis, the course is viewed as a training system, which is defined as a set of elements organized to develop knowledge and skills in individuals that will enable them to do a job or jobs according to defined criteria, in specified environments, for a given length of time. Under this definition, training system is a flexible concept that may be restricted to a single course, or expanded to encompass the entire set of training activities required to operate and maintain a weapon system throughout its life cycle. In use, therefore, the scope of the training system and the context in which it is used must be specified. When training system is used herein, it refers to the course.

In common with all systems, the course has a development cycle. Course development and conduct activities may be categorized in different ways. For this model the sequence of development is separated into four phases: requirements establishment, planning and design, development, and operation and control.

These categories suit the purposes of this model and generally agree with most systems models. The requirements establishment phase consists of all of the activities required to develop a training plan. Planning and design--sometimes considered as separate phases in the development cycle--are combined here, because the differences appeared to be a matter of successive levels of detailing, rather than differences in kinds of activity. The development phase includes all installation, checkout, validation, and other activities required before operation may begin. In the Interservice Procedures for Instructional System Development Model (Branson et al., 1975), operation and control are separate phases. However, they are combined here in the belief that the activities involved usually share a common time frame and, even more importantly, are parts of the same organization and budget.

between systems for short-supply personnel or the presence or absence of an all-volunteer force condition.

In a large weapon system development cycle, this course evolution usually involves major changes in the nature of the course as taught at different times. The point is that what is consistently identified as the same course, because of the continuity of the subject matter, may in fact involve rather large differences between iterations. Major factors that can produce such differences or changes are: changes in course purpose, changes in entering student characteristics, weapon system modifications, and improvements in instructional technology.

While changes in course purpose may arise from the stage of system development requirements, they may also arise from changes in the mission of the weapon system stemming from such causes as the outbreak of hostilities or changes in defense posture. In the latter stages of a system's life, training that was previously specific to the system, may be added to general billet training courses, when this occures, the training requirements for a specific course will be reduced and the course may eventually be eliminated.

Weapon system modifications begin shortly after the beginning of prime system development and continue throughout the life of the system. Many of these modifications have an impact on the training of, at least some, personnel. Probably no course escapes the need for frequent change because of this factor. Although modifications may be small and less frequent (and therefore less expensive) in general career development courses, in system-oriented training they are apt to be frequent and sometimes major, resulting in significant costs.

A course is an evolving development of a subject area with relatively frequent modifications to adapt to changing goals, requirements, and technologies. One implication for costing training involves the practice of categorizing the various costs of a course as either initial investment or recurring operating costs. This approach should be broadened to include a category of redevelopment or recurring investment costs.

approaches. Perhaps the most important reason is that the course is the conventional unit of training historically used for recordkeeping that will permit the model to be used for costing past and current system training efforts.

The simple definition of a course to be used here is: an integrated set of instructional events designed and conducted to provide a student with the knowledge and skills required for a defined job; it is normally identifiable so that successful completion may be entered in the student's personnel record. This definition is not adequate for the purpose of the model, since it implies that the course is a relatively static entity. Like a prime system, a course proceeds through stages of modification to meet changing conditions with its own life cycle.

Course Evolution During Its Life Cycle

One major set of changes is directly related to the weapon system development cycle. The earliest training requirements stem from prime systems test and evaluation activities. This training, which is typically developed and conducted by contractors, is usually referred to as factory training and the number of individuals trained is typically small. Later in the system development, initial crews must be trained to operate and maintain the system. At this point there is usually an expansion of the training requirements, a need for increased standarization and formalization of training, and a potential for using instructional technology to increase training efficiency since larger numbers of individuals will need to be trained. During this period, initial-crew training may be carried out by the contractor or the Navy--or it may be in transition from the one to the other.

After the initial crews have been trained, the course will be repeated as needed to train follow-on, or replacement, crews. Further modifications of the course may be required at this point to adapt to the change from highly skilled students who often had been hand picked for initial crews to average ability students. Typically, the Navy conducts follow-on training. Other changes may occur as the result of competition

when modifications requiring personnel training will occur, some attempt must be made because expenditure of large sums of money are involved. At least a projection based on historical records of similar systems should be useful.

13. On-the-job training (OJT), which is defined as improvement of present skills and acquisition of new skills while in the work environment, is probably an inseparable part of work experience. While OJT in this context exceeds the scope of this study, formal OJT should be considered as an alternative to formal school (e.g., "A" school) for weapon system training. Weiher and Horowitz (1971) stated that "the vast majority (of ratings) ... have men who have reached E-4 by both the "A" school route and via OJT exclusively." The decision to include OJT cost in a system acquisition is still best left to the acquisition managers.

The work by Weiher and Horowitz (1971) contains much detail on Navy ratings and should be seriously considered as the guide for forecasting OJT costs if they are to be included in total training costs.

Training Model Unit

Selection of the Unit

The complexity of the training required during the life cycle of a modern weapon system clearly indicates that a general training model is needed both for costing and planning as well as to keep the bookkeeping straight in both cases. For either case, the model needs a unit that can serve as point of focus on a reference. This reference is needed to provide a consistent basis of analysis for costing and as a coherent building block for generating the overall structure of system training.

The course was chosen as the unit for the training model for a number of reasons. It is an existing concept, generally understood by training professionals and laymen alike. It is a meaningful amount of training to cost. It encompasses a great diversity of training. It may refer to a block of conventional classroom training, OJT group instruction, individualized instruction, appropriate combinations of these, or other training

modified version of the contractor supplied material. Typical reasons for training material modification are student load variations, student entry-level capability changes, training technology changes, equipment modifications, and prime system mission changes.

9. The fleet schools provide refresher and team training for the officers and enlisted personnel, who normally are members of ship's company. The training may include "A" and "C" courses.

10. The training required by personnel at shipyard/depot facilities is a function of the weapon system maintenance requirements. Special processes and overhaul techniques will usually require a one-time contractor-conducted depot-level training course. In turn, the graduates of this course will train other personnel. If a major acquisition program were to exceed a shipyard's workload or technological capabilities, an extensive training program could be implemented.

11. A new weapon system normally introduces new technology into the fleet. The initial crew training includes the fundamental technology required to operate and maintain the system. As the fleet acquires more weapon systems with this technology, the technical fundamentals will become part of "A" and "C" school curricula and will be eliminated from the system course. For example, on DD 963 class ships, IC and ET ratings with digital-electronic background are needed for the propulsion control equipment. The first crews received digital fundamentals training as part of the equipment training at the factory and the Naval Training Center, Great Lakes. When later crews received this training in "A" school, the equipment training course was reduced.

Since the technology transfer between schools only shifts the cost from one school to the other, the cost of the transfer would be the only change in the total weapon system training cost. This should be verified by a study of actual case histories.

12. Technological advances that economically satisfy weapon system requirements normally result in modification of the system equipment and training. Although it is not always possible to forecast with a high degree of certainty, the number, size, and time

2. NAVSEAINST 4105.1 requires the Fleet Support Directorate to provide command integrated logistic support (ILS) training programs.

3. Typical test and test support training includes training personnel for: operational evaluation (OPEVAL), technical evaluation (TECHEVAL), maintainability demonstration (M-Demo), and installation crews.

4. Prerequisite training is normally conducted by the Navy on government-furnished equipment (GFE) that will be installed on the ship (e.g., the AN/UYK-7 on the DD 963 class). Also in some cases, successful completion of certain "A" or "C" schools conducted by the Navy or the appropriate contractor may be required for a specific ship-system course.

5. Individual and team training of the first crew(s) and the initial cadre of Navy instructors is usually accomplished by the contractor at the shipyard or other facilities (C-2 signifies a class "C" school conducted at contractor facilities, while C-1 would be conducted at government facilities). Occasionally, Navy instructors conduct portions of the initial training at the contractor facilities.

6. Usually support personnel training includes the following personnel: metrology and calibration (METCAL), mobile technical unit (MOTU), fleet inspection team (FIT), direct fleet support, and tanker/tender crews.

7. The initial cadre of Navy instructors normally conducts courses for early ship crews, while contractor instructors provide advisory services such as observing and critiquing, with technical assistance as required. The training is usually conducted at the Navy school facility, but may be conducted at a contractor's facilities. Normally, the training material used during the contractor-conducted crew training is also used during early classes conducted by the Navy.

8. The remaining initial crew training, is usually conducted by Navy instructors at the functional school established for that purpose. The students during this period also include replacement crew members. The training material used school is normally a

Ship Training Activities

The ships' life cycle phases from Figure 2 are used as the framework to identify training activities in Figure 3. The training activities are located (in Figure 3) where the actual conduct of training is most likely to occur during the life cycle. However, the efforts to establish requirements to, plan, design, and develop this training will occur much earlier in the life cycle. Also, actual training activities may vary with ship systems (e.g., an aircraft carrier would have to include training of aircrews and airplane maintenance and support personnel). All training is referenced in OPNAVINST 1500.8H.

1. Technology training deals with the transfer of information in the Navy's technological base (NAVMATINST 3910.13) to the personnel tasked with producing the weapon system. In many cases personnel from the Naval Engineering Laboratory serve as consultants to the responsible project office usually, the attainment and transfer of the technological information, requires the expenditure of funds for training.

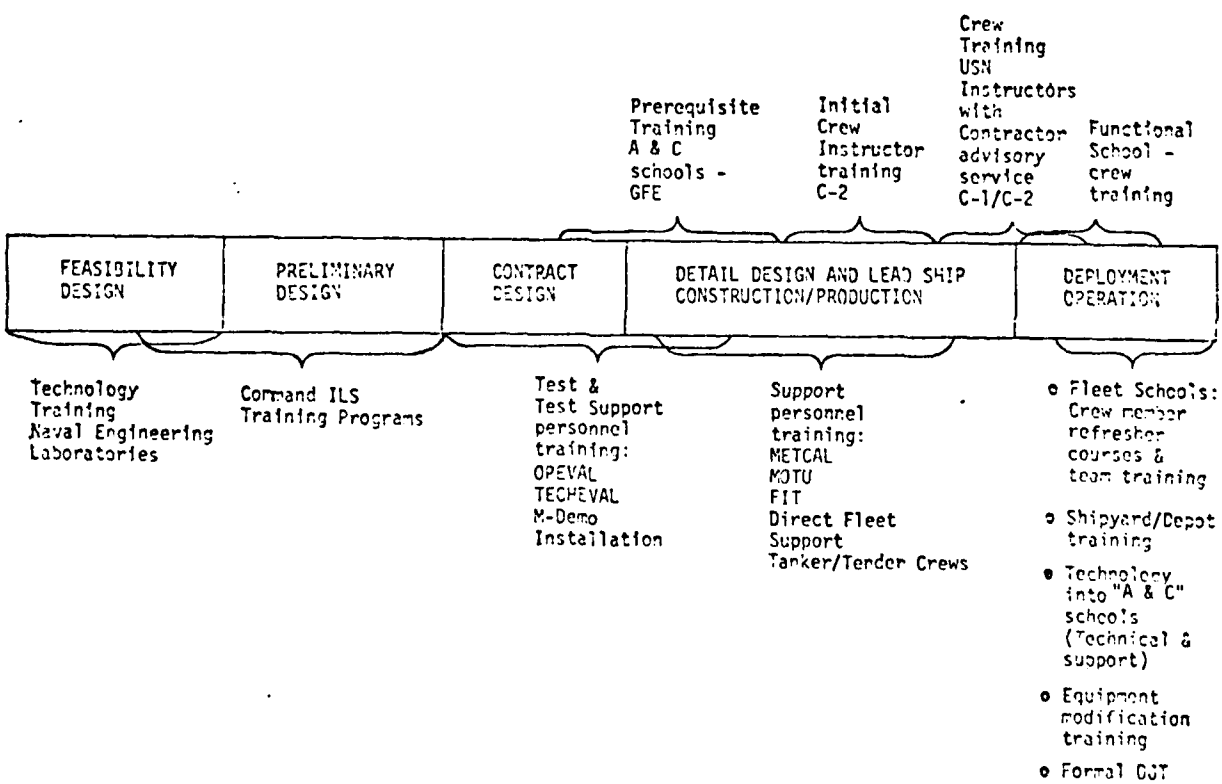


Figure 3. Training activities for ships' life cycle phases.

1. Requirements establishment phase includes the resources necessary to identify the training requirements for personnel who will operate and maintain the weapon system (see Figure 7). From a total weapon system viewpoint, the Logistic Support Analysis (LSA) is the major input data for ths phase and the training portion of the Integrated Logisitc Support Plan (ILSP) summarizes the effort. Military Standards 1369 and 1388 describe much of the process. The use of a consultant during this phase is described in NAVMATINST 5311.3.

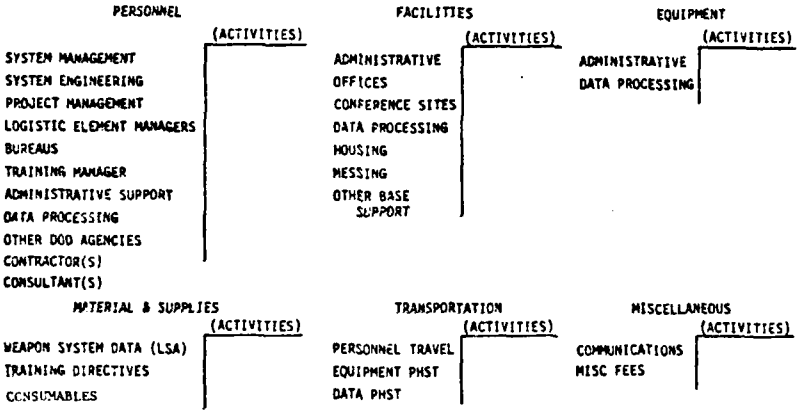


Figure 7. Requirements phase.

2. During the planning and design phase the planning for billets, personnel, facilities, and training for each course is accomplished (see Figure 8). The summary of all training will be incorporated into the Navy Training Plan (NTP) for the weapon system. OPNAVINST 1500.8 describes this process.

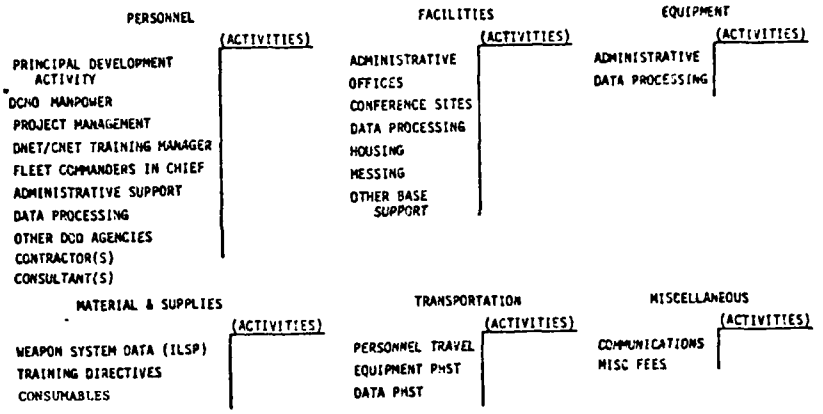


Figure 8. Planning and design phase.

3. Development phase consists of the implementation of the NTP (see Figure 9). Capabilities of existing courses are expanded, discontinued courses may be reactivated, contracts are awarded to conduct training programs and manufacture training equipment, facilities and personnel are acquired, and training equipment is installed in the learning environment.

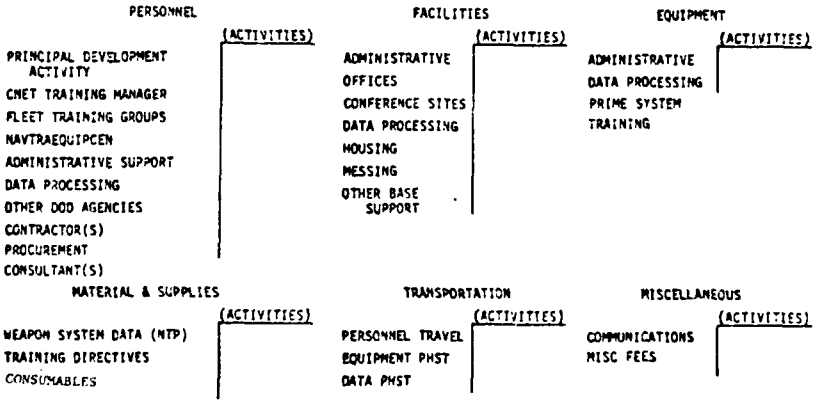


Figure 9. Development phase.

4. During the operation and control phase the course is actually conducted (see Figure 10). Evaluation of student performance in the work environment along with feedback for course modification is also included.

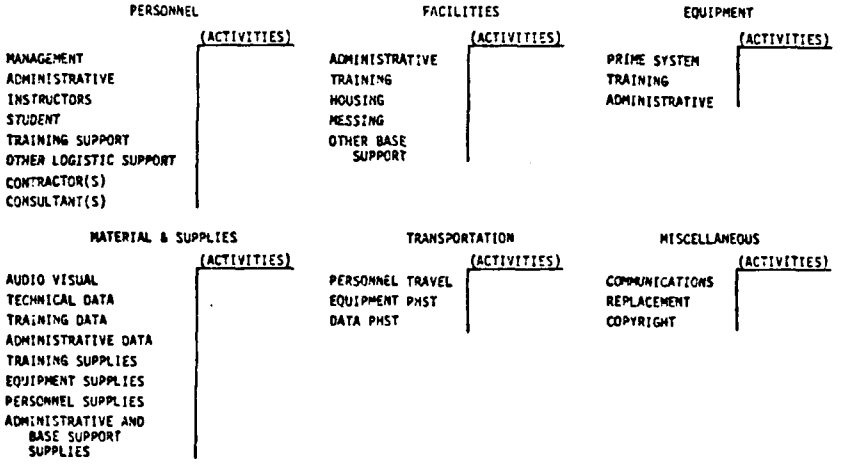


Figure 10. Operation and control phase.

An analysis of the cost of course activities is also useful in a cost effectiveness evaluation. This is accomplished by accumulating the totals for each cost element involved with each course activity, across all course phases. Figure 11 illustrates the process in the same manner that Figure 6 illustrated the cost elements per phase.

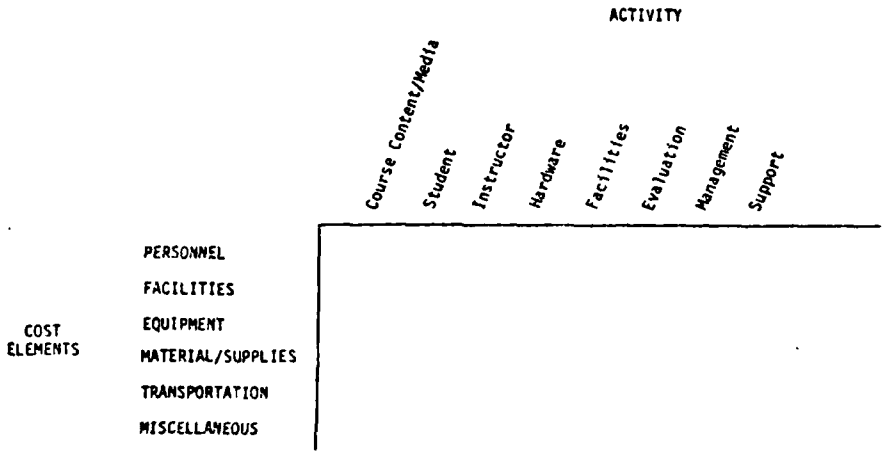


Figure 11. Cost elements per course activity.

The details of each cost element may be listed in the same manner as shown in Figures 7 through 10 for the course phases. For example, the personnel, facilities, and equipment used to establish requirements, plan (and design), develop, and operate the training course facilities would be detailed on one chart and the total costs listed under facilities column of Figure 11.

Course Cost Matrices

When Figures 7 and 11 are combined with the cost elements as the common side of a matrix, the training course cost model assumes the three-dimensional shape of Figure 12.

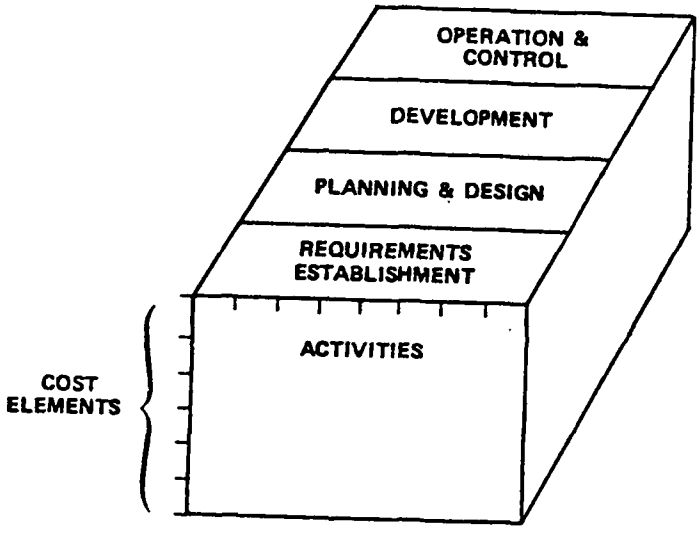


Figure 12. Training course cost model.

The course model is segmented into three dimensions--cost elements, activities, and phases (Figure 13) to provide a comprehensive three-way analysis of course costs. The X-plane in Figure 13 provides the element cost per phase for any of the eight course activities, or the total activity cost. The Y-plane provides total phase cost. The Z-plane provides cost element totals. The X- and Y-planes are most useful for examining the cost of the internal operation of the training course cost (e.g., what is the cost ratio between the planning and the operation phases, or how do the student-related activities compare to the instructor-related activities?). The Z-plane is most useful for comparing the cost of one course with another course, or with alternative methods of instructional delivery (e.g., computer based instruction).

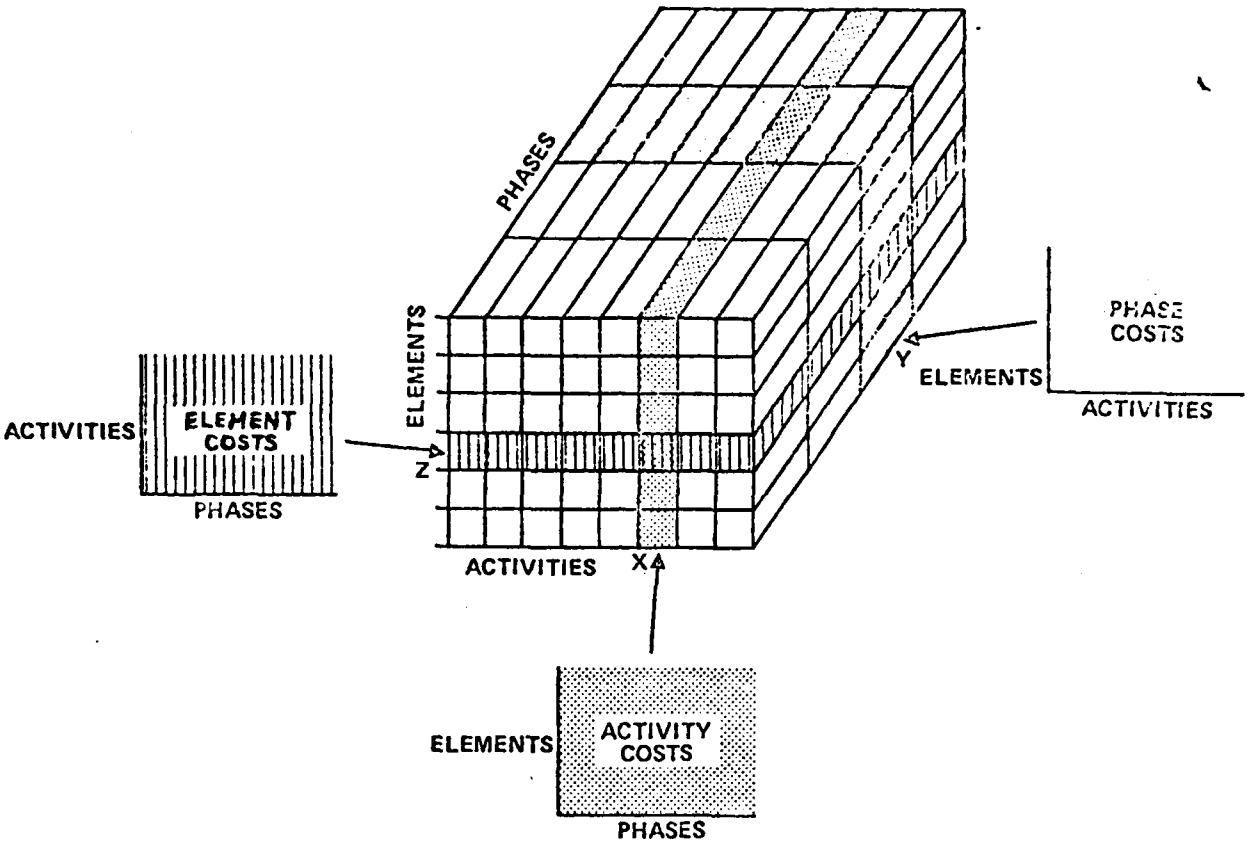


Figure 13. Training course cost matrices.

Life Cycle Costs

Weapon System Life Cycle

The fundamental point of life cycle cost analysis is to identify the full economic cost of a proposed future course of action. To facilitate the analytical process for a proposed new weapon system, the proposed costs are segregated into three cost categories:

1. Research and development costs. The resources required to develop the new capability to the point where it can be introduced into the operational inventory at some desired level of reliability.

2. Investment costs. The one-time outlays required to introduce the capability into the operational inventory.

3. Operation costs. The recurring outlays required annually to operate and maintain the capability in service over a period of years. An illustration of the

relationship of these costs in the life of a system is presented in Figure 14, an extration from Fisher (1971). These major cost categories of the weapon system development cycle are of interest to training managers because they identify budget planning phases and each is associated with unique training programs.

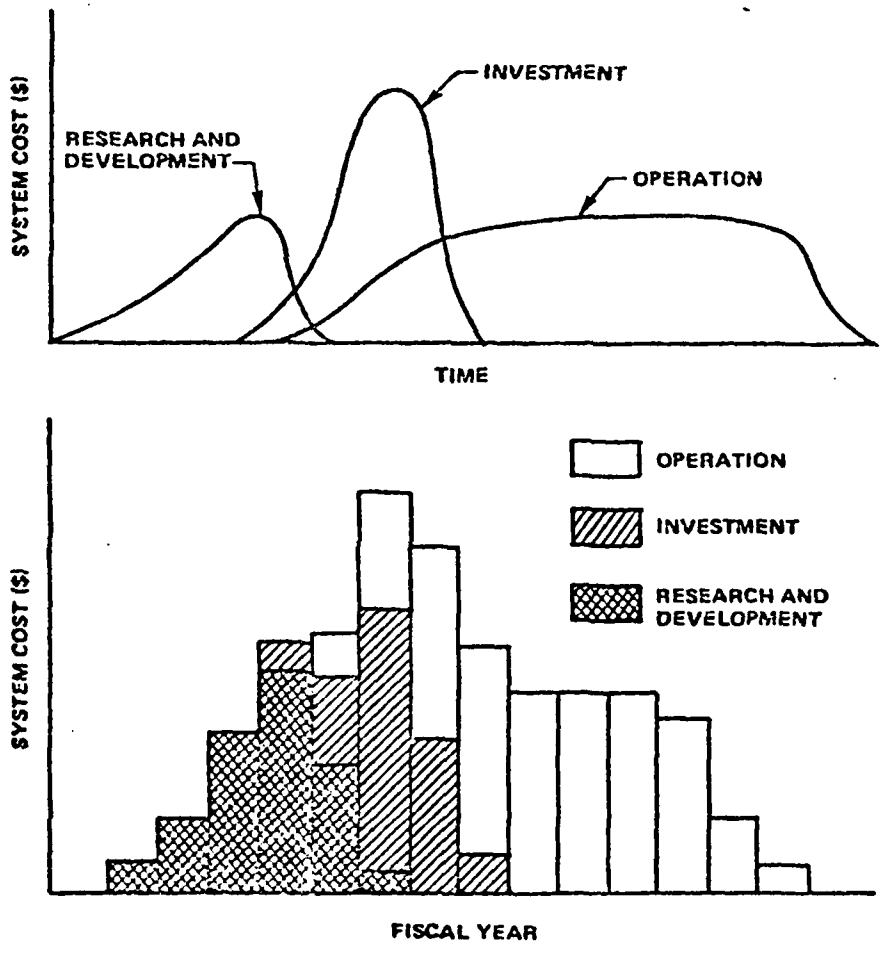


Figure 14. Examples of weapon system life cycle cost profiles (from Fisher, 1971).

Life Cycle Training Cost Model

The training course cost model (Figure 13) is the basic building block for the life cycle training cost model in Figure 15. Each of the cells in Figure 15 represents a weapon system training course. Each course cell contains the phases, activities, and cost elements illustrated in Figure 13. The total life cycle training cost is the sum of the costs for each course.

The model is divided into three separate periods of training--test and evaluation (T&E), initial, and follow-on--that are associated with the three weapon system life cycle categories. For a system analysis, the cost of each of these training periods becomes a part of its applicable weapon system life cycle category. For life cycle training costs, all three groups are summed together. The horizontal dimension of Figure 15 represents the type of training required by the different phases and functions of the weapon system life cycle.

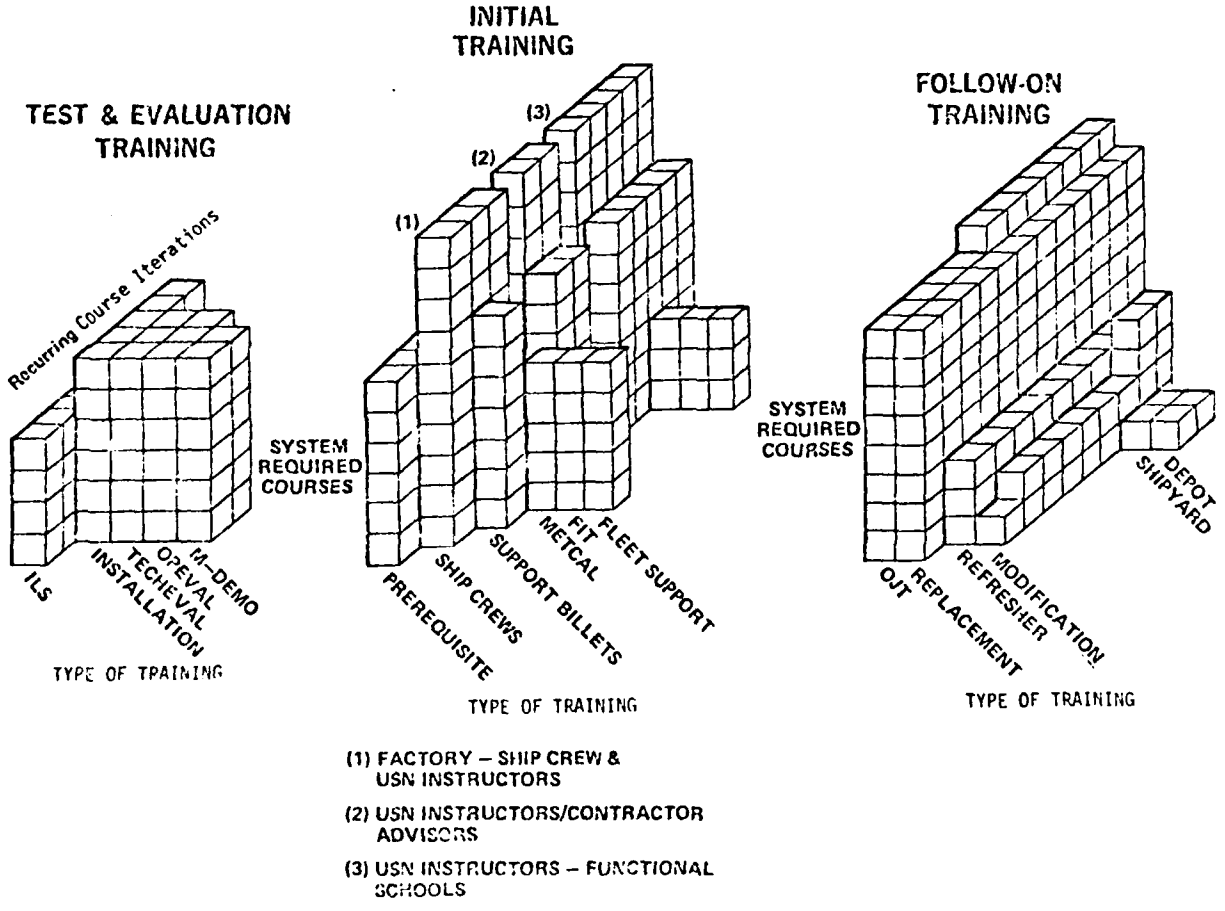


Figure 15. Life cycle training cost model.

The vertical dimension of Figure 15 represents the different courses necessary to provide the full complement of trained personnel required to complete the mission applicable to this type of training. For example, maintainability demonstration (M-demo) training requires trained maintenance personnel to perform the maintenance tasks to be evaluated, trained operators and other personnel to support the exercise, and finally, evaluators trained to make the evaluations.

The remaining dimension of this model illustrates recurring iterations of a course. In the T&E phase, the number of iterations is a function of both the complexity of the weapon system and the duration of the phase. In the initial phase the number of iterations is primarily a function of the number of weapon systems to be manned. Finally, the number of follow-on iterations, which is related primarily to the operational life of the system, is also a function of such factors as personnel tour-of-duty length, system mission requirements, system modifications, and maintenance requirements.

A word of caution to those estimating the cost of recurring iterations. Although, at first glance, the operating costs of the first course simply appear to be repeated whenever the course is conducted, this is seldom the case. The evaluation process usually reactivates the other three phases. Also, changes in training technology, student entry level capabilities, or student pipeline fluctuations will modify the course and cause the costs of subsequent iterations to vary.

At the present level of development, the use of the life cycle training cost model is conceptually simple:

1. The number of different courses required is estimated.
2. For each course, the number of iterations and probable modification are estimated.
3. For each iteration, the costs of activities are estimated for each course development phase.
4. Iterations are summed to obtain total estimated course cost.

5. The costs of the individual courses are summed to obtain total estimated system training costs.

Costing sophistication, such as that involved in discounting to the year of estimate, is assumed in this oversimple set of procedures. Some of the obvious factors that will complicate actual costing or cost estimation efforts are examined in Appendix B.

RESULTS AND CONCLUSIONS

1. Using the course as a training unit, an initial model was developed to determine the cost of training required for the life cycle of a weapon system.

2. At this level of development, the model provides a structure for relating the training required during weapon system development and test with the subsequent initial crew and ongoing replacement training. It provides a single coherent point of reference for system training managers, instructional technologists, and training cost accountants alike.

3. The life cycle training cost model is descriptive rather than directive. The finest level of detailing of the model was chosen to exploit the finest level of costing information likely to be available, while still leaving the model general enough to be applicable to the widest number of alternative forms of training and training development.

RECOMMENDATIONS

1. The model should be applied to an actual weapon system for both fine tuning and validation.

2. Future work should build upon the structure of this model to create the cost base necessary for developing a life cycle training cost model and supporting data base including specific cost figures and formalas needed to establish costs for individual training systems.

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APPENDIX A

COURSE PHASE ACTIVITIES DETAIL EXERCISE

TABLE A-1

REQUIREMENTS PHASE - CONTENT/MEDIA ORIENTED FUNCTIONS

CONDUCT TASK AND SKILLS ANALYSIS (TASA)

DEVELOP QUANTITATIVE AND QUALITATIVE PERSONNEL REQUIREMENTS INFORMATION (QQPRI)

DEVELOP JOB QUALIFICATION STANDARDS

ESTABLISH KNOWLEDGE AND SKILLS LEVELS OF PROJECTED AVAILABLE STUDENTS

ESTABLISH TRAINING REQUIREMENTS

DEVELOP INITIAL ESTIMATES OF MEDIATION REQUIREMENTS

DETERMINE STUDENT EVALUATION REQUIREMENTS

ESTABLISH COURSE SCOPE AND DURATION

CARRY OUT REQUIRED INTERAGENCY LIAISON

INPUT TO TRAINING PLAN

TABLE A-2

REQUIREMENTS PHASE - STUDENT ORIENTED FUNCTIONS

DETERMINE NUMBER OF STUDENTS REQUIRED

DETERMINE GRADUATE PRODUCTION TIMELINES

ESTABLISH STUDENT ENTRY QUALIFICATION REQUIREMENTS

ESTABLISH STUDENT SUPPORT REQUIREMENTS

CARRY OUT REQUIRED INTERAGENCY LIAISON

INPUT TO TRAINING PLAN

TABLE A-3

REQUIREMENTS PHASE - INSTRUCTOR ORIENTED FUNCTIONS

DETERMINE NUMBER OF INSTRUCTORS REQUIRED

DETERMINE INSTRUCTOR REQUIREMENT TIMELINES

ESTABLISH INSTRUCTOR QUALIFICATIONS REQUIRED

ESTABLISH INSTRUCTOR SUPPORT REQUIREMENTS

CARRY OUT REQUIRED INTERAGENCY LIAISON

INPUT TO TRAINING PLAN

TABLE A-17

DEVELOPMENT PHASE - CONTENT/MEDIA ORIENTED FUNCTIONS

DEVELOP INSTRUCTIONAL MANAGEMENT PLAN

DEVELOP INSTRUCTIONAL MATERIALS FOR SYSTEM, REMEDIAL AND PRE-TRAINING

DEVELOP LESSON PLANS, LESSON GUIDES, LESSON SUPPORT MATERIALS

VALIDATE INSTRUCTIONAL MATERIALS AND PLANS

DEVELOP RECORD KEEPING SYSTEM

DEVELOP LIBRARY AND LIBRARY MANAGEMENT PLAN

TABLE A-16

PLAN/DESIGN PHASE - SUPPORT FUNCTIONS

DESIGN INTEGRATED LOGISTICS SUPPORT FOR TRAINING SYSTEM ELEMENTS:

- CONTENT/MEDIA
- PERSONNEL
- HARDWARE
- FACILITIES

ESTABLISH REQUIREMENTS FOR SUPPORT PIPELINES

DEVELOP SUPPORT PERSONNEL ACQUISITION AND TRAINING PLAN

TABLE A-15

PLAN/DESIGN PHASE - MANAGEMENT FUNCTIONS

DESIGN MANAGEMENT ORGANIZATION

DEVELOP DETAILED SCHEDULING REQUIREMENTS

DESIGN RECORD KEEPING SYSTEM

DESIGN BUDGETING AND ACCOUNTING SYSTEMS

DESIGN INTERNAL AND EXTERNAL COMMUNICATION SYSTEM

DESIGN SUPPORT MANAGEMENT SYSTEM

TABLE A-14

PLAN/DESIGN PHASE - TRAINING SYSTEM EVALUATION FUNCTIONS

DEVELOP EVALUATION PLAN

DESIGN EVALUATION INSTRUMENTS

DESIGN DATA ANALYSIS ROUTINES AND EVALUATION PROCEDURES

DESIGN RECORD KEEPING AND DATA DISTRIBUTION SYSTEM

TABLE A-13

PLAN/DESIGN PHASE - FACILITIES FUNCTIONS

DEVELOP FACILITIES PLAN

DESIGN NEW FACILITIES AND EXISTING FACILITIES MODIFICATIONS

DEVELOP PLAN FOR HARDWARE INTEGRATION INTO FACILITIES

DEVELOP FACILITIES USE PLAN

TABLE A-12

PLAN/DESIGN PHASE - HARDWARE ORIENTED FUNCTIONS

DEVELOP HARDWARE ACQUISITION PLAN

DESIGN HARDWARE ELEMENTS

DEVELOP PLAN FOR INTEGRATION OF HARDWARE IN LEARNING ENVIRONMENTS

DEVELOP HARDWARE INSTALLATION AND CHECKOUT PLAN

TABLE A-11

PLAN/DESIGN PHASE - INSTRUCTOR ORIENTED FUNCTIONS

DEVELOP INSTRUCTOR ACQUISITION PLAN

DESIGN INSTRUCTOR TRAINING COURSES

DEVELOP INSTRUCTOR ASSESSMENT AND ASSIGNMENT PLAN

DESIGN INSTRUCTOR HANDLING PLAN

TABLE A-10

PLAN/DESIGN PHASE - STUDENT ORIENTED FUNCTIONS

ESTABLISH COURSE ENTRY REQUIREMENTS

PLAN STUDENT ACQUISITION PIPELINE

DESIGN STUDENT HANDLING SYSTEM

TABLE A-9

PLAN/DESIGN PHASE - CONTENT/MEDIA FUNCTIONS

DEVELOP OBJECTIVES AND TESTS

ESTABLISH INSTRUCTIONAL STRATEGY

ESTABLISH COURSE OUTLINE

DETERMINE MEDIATION OF COURSE CONTENTS

ESTABLISH COURSE ENTRY REQUIREMENTS

DESIGN CONTENT AND MEDIA DEVELOPMENT PLAN

TABLE A-8

REQUIREMENTS PHASE - SUPPORT FUNCTIONS

ESTABLISH REQUIREMENTS FOR INTEGRATED LOGISTIC SUPPORT FOR TRAINING SYSTEM:

- CONTENT/MEDIA
- PERSONNEL
- HARDWARE
- FACILITIES

ESTABLISH SUPPORT AVAILABILITY TIMELINE REQUIREMENTS

ESTABLISH REQUIREMENTS FOR KINDS AND NUMBERS OF SUPPORT PERSONNEL

ESTABLISH REQUIREMENTS FOR SUPPORT PERSONNEL TRAINING

ESTABLISH REQUIREMENTS FOR SUPPORT EQUIPMENT AND FACILITIES

CARRY OUT INTERAGENCY LIAISON

INPUT TO TRAINING PLAN

TABLE A-7

REQUIREMENTS PHASE - MANAGEMENT FUNCTIONS

ESTABLISH REQUIREMENTS FOR TRAINING SYSTEM MANAGEMENT

ESTABLISH AVAILABILITY OF EXISTING MANAGEMENT ORGANIZATIONS THAT MAY BE USED

DETERMINE SCOPE OF ADDITIONAL MANAGEMENT REQUIRED FOR THIS SYSTEM

ESTABLISH REQUIREMENTS FOR MANAGEMENT TOOLS (HARDWARE/SOFTWARE)

CARRY OUT INTERAGENCY LIAISON

INPUT TO TRAINING PLAN

TABLE A-6

REQUIREMENTS PHASE - TRAINING SYSTEM EVALUATION FUNCTIONS

ESTABLISH KINDS OF TRAINING SYSTEM EVALUATION REQUIRED

ESTABLISH FREQUENCY OF TRAINING SYSTEM EVALUATION REQUIRED

CARRY OUT INTERAGENCY LIAISON

INPUT TO TRAINING PLAN

TABLE A-5

REQUIREMENTS PHASE - FACILITIES FUNCTIONS

ESTABLISH KIND AND AMOUNT OF SPACE REQUIRED FOR:

- TRAINING CONDUCT
- TRAINING ADMINISTRATION
- MATERIALS STORAGE
- HARDWARE STORAGE
- TRAINING SYSTEM SUPPORT FUNCTIONS

ESTABLISH FACILITIES AVAILABILITY TIMELINE REQUIREMENTS

ESTABLISH FACILITIES SUPPORT REQUIREMENTS

CARRY OUT INTERAGENCY LIAISON

INPUT TO TRAINING PLAN

TABLE A-4

REQUIREMENTS PHASE - HARDWARE ORIENTED FUNCTIONS

ESTABLISH KINDS OF MEDIA HARDWARE REQUIRED

ESTABLISH NUMBERS OF MEDIA HARDWARE REQUIRED

ESTABLISH MEDIA HARDWARE DEVELOPMENT AND OPERATION TIMELINE REQUIREMENTS

ESTABLISH TRAINING SYSTEM HARDWARE REQUIREMENTS (E.G., TRAINING MANAGEMENT SYSTEM)

ESTABLISH TRAINING SYSTEM HARDWARE DEVELOPMENT AND OPERATION TIMELINE REQUIREMENTS

ESTABLISH HARDWARE SUPPORT REQUIREMENTS

CARRY OUT INTERAGENCY LIAISON

INPUT TO TRAINING PLAN

TABLE A-18

DEVELOPMENT PHASE - STUDENT ORIENTED FUNCTIONS

DEVELOP AND VALIDATE ENTRY ASSESSMENT TEST

DEVELOP EVALUATION AND ASSIGNMENT PROCEDURES

DEVELOP RECORD KEEPING SYSTEM

DEVELOP STUDENT TRACKING SYSTEM

DEVELOP REPORTING PROCEDURES

TABLE A-19

DEVELOPMENT PHASE - INSTRUCTOR ORIENTED FUNCTIONS

DEVELOP EVALUATION AND ASSIGNMENT PROCEDURES

DEVELOP INSTRUCTOR TRAINING, SYSTEM AND METHODS

VALIDATE INSTRUCTOR TRAINING

DEVELOP INSTRUCTOR RECORD KEEPING SYSTEM

DEVELOP REPORTING PROCEDURES

TABLE A-20

DEVELOPMENT PHASE - HARDWARE ORIENTED FUNCTIONS

DEVELOP/ACQUIRE EQUIPMENT, INSTALL, CHECKOUT

DEVELOP HARDWARE USE PLAN

DEVELOP HARDWARE MODIFICATION/UPDATE PROCEDURES

DEVELOP EVALUATION AND RECORD KEEPING SYSTEM

DEVELOP REPORTING PROCEDURES

TABLE A-21

DEVELOPMENT PHASE - FACILITIES FUNCTIONS

DEVELOP/ACQUIRE FACILITIES, CHECKOUT

PREPARE FACILITIES/INSTALL EQUIPMENT, CHECKOUT

DEVELOP EVALUATION AND RECORD KEEPING SYSTEM

DEVELOP REPORTING PROCEDURES

TABLE A-22

DEVELOPMENT PHASE - TRAINING SYSTEM EVALUATION FUNCTIONS

DEVELOP SYSTEM ELEMENT PERFORMANCE MEASURES

DEVELOP ELEMENT MEASUREMENT PROCEDURES

DEVELOP DATA ANALYSES AND EVALUATION PROCEDURES

DEVELOP RECORD KEEPING SYSTEM

DEVELOP REPORTING PROCEDURES

TABLE A-23

DEVELOPMENT PHASE - MANAGEMENT FUNCTIONS

DEVELOP AND CHECKOUT TRAINING SYSTEM MANAGEMENT ORGANIZATION AND PROCEDURES

DEVELOP SCHEDULING PROCEDURES

DEVELOP CADRE

ESTABLISH RECORD KEEPING SYSTEM, PROCEDURES, INITIAL DATA BANK

ESTABLISH AND INITIALIZE BUDGET AND ACCOUNTING SYSTEM

ESTABLISH EXTERNAL LIAISONS

DEVELOP SUPPORT SYSTEM MANAGEMENT AND PROCEDURES

TABLE A-24

DEVELOPMENT PHASE - SUPPORT FUNCTIONS

DEVELOP INTEGRATED LOGISTIC SUPPORT PROCEDURES FOR:

- CONTENT/MEDIA
- PERSONNEL
- HARDWARE
- FACILITIES

ESTABLISH AND CHECKOUT SUPPORT PIPELINES

DEVELOP AND TRAIN SUPPORT PERSONNEL

TABLE A-25

OPERATION AND CONTROL PHASE - CONTENT/MEDIA FUNCTIONS

LIBRARY OPERATION

- MANAGEMENT
- ACQUISITION/RECEIVING
- CATALOGING/STORING

MATERIALS DISTRIBUTION

- TRANSPORTATION
- REACQUISITION
- RECORDING

ASSESSMENT AND REPORTING

- LIBRARY STATE MONITORING/EVALUATION
- REQUIREMENT GENERATION
- REPORTING

REVISE AND UPDATE

- MATERIALS CHANGE IMPACT ASSESSMENT AND INTEGRATION
- MATERIALS DEVELOPMENT/ACQUISITION
- MATERIALS PRODUCTION/DUPLICATION

TABLE A-26

OPERATION AND CONTROL PHASE - STUDENT ORIENTED FUNCTIONS

RECEIVING

ENTRY ASSESSMENT

ASSIGNMENT

RECORDS ESTABLISHMENT AND MAINTENANCE

PROGRESS MONITORING AND EVALUATION

COUNSELING

PROGRESS REPORTING

TABLE A-27

OPERATION AND CONTROL PHASE - INSTRUCTOR ORIENTED FUNCTIONS

RECEIVING

ENTRY ASSESSMENT

ASSIGNMENT

RECORDS ESTABLISHMENT AND MAINTENANCE

INSTRUCTOR TRAINING

STATUS MONITORING/EVALUATION

STATUS REPORTING

INSTRUCTION (TEACHING, COUNSELING, MANAGEMENT)

TABLE A-28

OPERATION AND CONTROL PHASE - HARDWARE ORIENTED FUNCTIONS

EQUIPMENT INVENTORY MAINTENANCE

- ACQUISITION/RECEIVING
- STORAGE
- RECORD MAINTENANCE

DISTRIBUTION

- PREPARATION/TRANSPORTATION/OPERATION
- REACQUISITION
- RECORDING

ASSESSMENT AND REPORTING

- INVENTORY STATE MONITORING/EVALUATION
- CHANGE REQUIREMENT MONITORING/EVALUATION
- REPORTING

REVISE AND UPDATE

- EQUIPMENT CHANGE IMPACT ASSESSMENT AND INTEGRATION

TABLE A-29

OPERATION AND CONTROL PHASE - FACILITIES ORIENTED FUNCTIONS

MONITORING AND ASSESSMENT

ASSIGNMENT

RECORDS MAINTENANCE

PREPARATION AND OPERATION

MODIFICATION REQUIREMENTS ESTABLISHMENT

STATUS REPORTING

TABLE A-30

OPERATION AND CONTROL PHASE - TRAINING SYSTEM EVALUATION FUNCTIONS

SYSTEM ELEMENTS PERFORMANCE MEASUREMENT/ASSESSMENT

- CONTENT MEDIA
- INSTRUCTORS
- EQUIPMENT
- FACILITIES
- EVALUATION
- MANAGEMENT SUPPORT

SYSTEM PERFORMANCE MEASUREMENT/ASSESSMENT

RECORDS MAINTENANCE

REPORTING

TABLE A-31

OPERATION AND CONTROL PHASE - MANAGEMENT FUNCTIONS

PLANNING

BUDGET AND FINANCE

SUPERVISION AND INSPECTIONS

ASSET MANAGEMENT AND SCHEDULING

RECORD KEEPING

SUPPORT MANAGEMENT

SYSTEM EVALUATION AND REVISION MANAGEMENT

EXTERNAL LIAISON

TABLE A-32

OPERATION AND CONTROL PHASE - SUPPORT FUNCTIONS
(INTEGRATED LOGISTIC SUPPORT FOR ALL TRAINING SYSTEM ELEMENTS)

PERSONNEL (CADRE AND STUDENTS)

- PAY AND ALLOWANCES
- FOOD AND HOUSING
- CLOTHING, UNIFORMS AND SPECIAL
- PERSONAL SERVICES

EQUIPMENT (ALL)

- ROUTINE MAINTENANCE
- INSPECTION/ASSESSMENT
- REPAIR/MODIFICATION
- SPARES MAINTENANCE
- REPAIR FACILITIES MAINTENANCE

MATERIALS AND SUPPLIES

- ACQUISITION/STORAGE/DISTRIBUTION
- RECORD KEEPING
- REPORTING

FACILITIES

- MAINTENANCE MANAGEMENT
- REPAIR/MODIFICATION MANAGEMENT
- OPERATION

APPENDIX B

COSTING COMPLICATIONS

COSTING COMPLICATIONS

The model was developed to simplify and bring order to a very complex area: costing the training required by a weapon system during its life cycle. However, when an actual costing effort is caried out, obvious complications will develop. Three of these areas of complication are examined as examples.

The first area has to do with the problem of the carryover of assets or value to a course iteration from previous iterations. This problem was produced by the decision to consider as the costing unit as single iteration of the course, rather than its entire life cycle. This problem complicates the process of determining such things as the ratio of operating costs to investment costs, or establishing average investment cost per iteration. Assuming the cost information is available, this problem can probably be solved by logically combining the costs to answer the question at hand. For example, if the total investment cost for the course life cycle is needed, the costs per unit for the first three phases are summed across all iterations. On the other hand, if the decision concerns the adequacy of the budget for yearly operation of a course for also carrying out redevelopment in the planned iterations, then the projected costs of the activities in the first three phases (redevelopment costs) could be combined with the operation phase costs for all years after the initial course development. The point is that this problem is a matter of matching the logic of the use of a model to the particular purpose for which it is being used. The problem the model has attempted to solve is that of organizing a sufficiently detailed data base in such a way that alternative questions may be appropriately answered.

A similar response may be made to the problems of how to handle elements that two or more courses may have in common. For example, the introductory lecture to a course

on fire-control subsystems might also be used as part of a general system familiarity course. If the same lecture is required by both courses, its investment and reinvestment costs may be split appropriately between the two courses. Similarly, if assets, such as audio-visual equipment, are shared by several courses, the costs of acquisition, operation, and support may be allocated between the courses involved on an appropriate percentage basis.

Undoubtedly, a more serious problem concerns the availability of detailed costs. Although the extent of this problem will not be determined until some actual costing exercises are conducted, this is obviously an area that may limit the usefulness of the model. The model was constructed to use a reasonably fine grain of detail in both training activities and cost categorization. Actual training approaches and accounting practices may not permit the use of the available levels of granularity. For example, only a ratio of preparation time to conduct time may be available within the overall cost of the course for factory training when much of an initial course content development tool place. A breakdown of the preparation into the various activities spelled out in the model may never have been attempted or even considered possible. In this case, the only cost figures available for the course as a cell in the life cycle matrix will be cost of operation (conduct), cost of development (the first three course development phases collapsed), and the sum of these two as the total course cost. (Of course, other cost factors may need to be added, such as those involved in the cost to the Navy for planning, procuring, and monitoring the factory training.) The point is that although the model does not produce data, it is a means of organizing the data to answer questions and support decision making. These are not considered limitations of the model but, rather, limitations imposed by the current accounting procedures. If no data were available at the level of granularity developed in the model, the model would be too detailed to be useful. The level of detail represented by the four development phaes, eight training element activity

areas, and the six cost element categories should be at least available for some recently developed training systems. If it is and, if it can be used to improve training planning decisions and training-system cost effectiveness, this will justify appropriate accounting changes.

The most serious potential costing complication lies in cost determination. Some of the activities required for training may be difficult either to cost or assign to a specific training system. The cost of interagency liaison, for example, is apt to be considered part of the operating costs of the agencies and not allocated to the weapon system involved, let alone to a particular training course. Training planning conferences may involve large numbers of personnel and considerable preparation and travel. Whether these may be sufficiently identified to charge them to the particular courses involved is doubtful. In the case of contracted training efforts, it may be difficult to isolate and determine all of the costs of procurement and contract monitoring (e.g., development of RFPs, cost proposal evaluation and award, or procurement agency costs).

Navy research and development efforts are increasingly oriented to training problems in specific systems and courses. Much of this work is carried out by contract. Development of the problem, contract management, and use of the results may represent course development costs, but may be difficult to determine.

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